

Potato Flour

and Its Use in the Baking Industry*

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POTATO flour, an old ingredient in breadmaking, has been mentioned in newspaper and magazine columns many times during 1948 and 1949 because of the greatly increased production of this foodstuff. Owing to the large potato surplus and the urgent need for food in Europe, the Commodity Credit Corporation of the U. S. Department of Agriculture in mid-1948 instituted a program to procure 460 million pounds of potato flour for export to France and the occupied zone of Germany. By May 15, 1949, about 321 million pounds of flour had been produced from the 1948 crop.

The nation's capacity for producing potato flour had previously been about 30 million pounds a year; actual production amounted to 15 to 20 million pounds annually. The increased capacity for producing flour from cooked potatoes has come about mainly by utilizing idle equipment in distilleries. "Double" drum driers ordinarily used in drying distiller's solubles were adapted to the job of flaking cooked mashed potatoes, regularly done in potato flour plants by "twin" drum driers or single drum driers equipped with auxiliary rolls. A considerable tonnage of uncooked flour has been produced for export during the past year by use of idle equipment in vegetable dehydration plants and by adoption of the steam-tube drying method. Chemical engineers at the Eastern Regional Research Laboratory have contributed to the adaptation of distillery equipment and development of the steam-tube drying method (1, 2).

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Historical Development

The use of potatoes in breadmaking goes far back into history. Bakers used peeled, cooked, and mashed potatoes to impart potato flavor and retention of freshness to their bread. Before compressed yeast came into general use, many bakers used as leavening agent a "ferment" of mashed potatoes, cooked flour, and yeast (4). The potato has long been recognized as an excellent yeast food. Not only have they been employed in the home and in bakeries to promote yeast fermentation, but potato juice and mashed potatoes are well established among laboratory workers as nutrients for fermentations in general.

Potato bread became common in Europe during the last century, and bakers who migrated to the United States from these countries brought with them the technology of potato-bread production. Potato flour was first made in this country during the first World War (5). It offered a potato product of uniform quality that could be stored indefinitely in a fraction of the space occupied by fresh potatoes. As a result of these advantages, use of potato flour among bakers has grown steadily, if not rapidly, ever since its introduction.

Potato flour manufactured years ago in Europe commonly had a high "rope" spore count. Bacterial rope spores multiply during the fermentation process, and the resultant finished loaf of "ropy" bread is unfit for human consumption because of the sticky, stringy crumb and the bad odor. The association of potato flour with rope in bread has been a difficult concept to overcome in the minds of some bakers. Also, during World War I, uncooked potato flour of poor quality was thrown on the market (3). This

flour is reported to have given unsatisfactory results in baking and created some prejudice against all potato flour. Recent preliminary tests at this Laboratory, however, have shown that uncooked potato flour processed with sulfur dioxide has a low total spore count. The growth of the potato flour industry has been slow because it has been necessary to prove by actual baking demonstrations that potato flour on the market today is a pure product of low rope spore count and that it makes tasty bread of good texture and keeping qualities.

Nature and Composition of Potato Flour

There has been some tendency to confuse "potato flour" with "potato starch." This is understandable because the terms starch and flour are used interchangeably with some products, such as tapioca. Potato starch, which is also used in the baking industry, consists of the raw starch granules that have been extracted from the potatoes. The conventional type of potato flour is made from cooked potatoes and contains all the potato except the peel. Undoubtedly it is cheaper to produce flour from uncooked, unpeeled potatoes than from cooked, peeled potatoes. The potatoes are sulfited after grinding to inhibit oxidative, enzymic activity and thus make the dried product light in color. Although a great quantity of uncooked potato flour exported to Europe under the emergency food program has been used in baking, it remains to be seen whether such a product will find acceptance in the United States. The United States Department of Agriculture has tests under way in which the baking quality of flour from uncooked, unpeeled potatoes is being evaluated.

Any discussion of the food value of potato flour should include its chemical analysis. A typical analysis, supplied by a manufacturer of cooked, peeled potato flour, is as follows:

	Percent
Moisture	7.2
Ash	3.2
Protein (N \times 6.25)	8.0
Fat	1.4
Crude fiber	1.6
Carbohydrate	78.7
Calcium	0.03
Magnesium	0.10
Potassium	1.59
Sodium	0.04
Iron	0.03
Copper	0.001
Phosphorus	0.18
Sulfur	0.12
Chlorine	0.12
Silicon	0.01

The moisture content of this sample was only about 7 percent. The moisture content of the potatoes from which the flour was manufactured was probably 80 percent or higher. One pound of potato flour is equivalent in solids content to about 5 pounds of cooked peeled potatoes. The carbohydrates of the potato have a high capacity for absorption of water.

Most of the carbohydrate in cooked potato flour is starch, all of which is gelatinized and in rather soluble form. Protein is present in generous amount, and most of it is soluble. Valuable mineral substances, particularly potassium, magnesium, and phosphorus, which are essential in stimulating yeast growth, are present in amounts adequate for vigorous fermentation. The value of active fermentation in bread-making cannot be overemphasized. A vigorous evolution of carbon dioxide and alcohol (vaporized at baking temperature) is required to give the desired porosity and texture in bread. Less volatile substances that remain in the final loaf and contribute to its flavor and aroma are also produced in the fermentation. The constituents of the potato are recognized as outstanding among bread ingredients for their ability to stimulate growth of yeast cells and activate fermentation of sugar.

Baking Properties

Two levels of potato flour are used in bread. The lower level, 2 to 3 percent potato flour (based on the wheat flour), is used in ordinary white bread, rye, whole wheat, and sweet doughs. The Federal Food Standards Committee for bread has recommended that potato flour in amounts up to 3 percent be considered as an optional ingredient that need not be declared on the label. A higher level of potato flour, about 6 percent, is used in "potato bread." Appreciably larger amounts of potato flour, for example about 15 percent, give a pronounced odor and taste of potatoes but a slightly gummy texture. All tasters do not agree that bread containing up to 6 percent potato flour has the taste and aroma of potatoes, but as a rule they agree that it possesses a distinct flavor. Flavor is an all-important item in bread or any other foodstuff.

No baking experiments with potato flour have been made at the Eastern Regional Research Laboratory, but manufacturers of potato flour have contributed the following statements from their technical reports.

The laboratory of J. E. Siebel and Sons Company, Chicago, Illinois, has found that bread made with 2 and 3

Potato flour has for many years found use as an additive in bread baking. Recent studies now provide a scientific basis for its function as a yeast stimulant and flavoring agent.

percent potato flour toasted better than corresponding controls. The toast was a richer, golden brown; toasting penetrated somewhat deeper into the slice. The crumb was drier and less stringy. The taste and aroma of the toasted potato bread were judged by 5 out of 6 persons to be superior to the control.

Several baking technologists have shown that potato flour in bread, crackers, and other baked goods gives added "bloom" or color to the crust and interior of the final product. It is frequently hard to obtain sufficient bloom, particularly when hard wheat flour is used.

It was observed in a laboratory study by C. J. Patterson Co., Kansas City, Mo., that addition of potato flour to a dough increases the absorption of water in direct proportion to the amount added. This is probably the explanation for the commonly mentioned observation that potato bread is softer and keeps fresh longer than ordinary bread. Results of this study indicate that more than 4 percent potato flour has a deleterious effect on the mixing characteristics of wheat flours. Farinograph determinations showed that mixing time (before reduction of dough consistency) decreased as more potato flour was used in the mixtures. These effects on mixing characteristics were more noticeable with southwestern-type Kansas flour than with a Minnesota flour of northwestern type. Loaf volume was unaffected by as much as 4 percent potato flour but decreased with larger amounts of potato flour in the make-up.

Formulas

Space does not permit listing of all the types of formulas in which potato flour is used. Formulas for 2 percent potato flour bread, 6 percent potato flour bread, and 12½ percent potato flour crackers have been selected to illustrate the wide utility of the product. Manufacturers of potato flour can supply formulas for use in all varieties of bread, rolls, buns, muffins, pretzels, pie dough, doughnuts, cakes, glazes, icing mixes, Danish pastry, coffee cake, cookies, and crackers. The increasing popularity of prepared mix-

es for yeast-raised doughnuts is perhaps the most important development in the domestic potato-flour industry during the past 12 years. Prepared mixes are a convenience to the baker in that they are of uniform composition and practically assure a final product of high quality, which is not always possible if the baker has to utilize inexperienced help to mix doughs.

Baking technologists are not in agreement as to whether potato flour should be added to the dough or the sponge, or divided between dough and sponge. Addition of the potato flour to the dough is perhaps preferred by most, although the type of flour used is an influencing factor.

Potato flour is obtainable in both the granular and powdered forms. The granular form is handled more easily since mixing it requires much less care. Fine flour is used mainly in preparing dry mixes. If used in a dough, fine flour should first be blended with the wheat flour and other dry ingredients to prevent lumping.

2% Potato Flour Bread (Wholesale)

	Sponge	Lbs.	Ozs.
Wheat flour		300	
Water		175	
Yeast		10	
Yeast food		1	4
Dough			
Wheat flour		200	
Water		125	
Potato flour		10	
Salt		11	4
Shortening		10	
Sweet condensed milk		50	
(Milk solids....28%)			
(Sugar42%)			
Milk solids, nonfat		4	

Sponge temperature—76° F.
Approximate mixing time—3 minutes
high speed
Fermentation time—5 hours

Dough temperature—81° F.
Approximate mixing time—10 min.
Floor time—20 to 30 minutes

6% Potato Flour Bread (Retail)

10 lbs. Wheat flour
10 oz. Potato flour
1 gal. Water (variable)
4 oz. Salt
4 oz. Yeast
8 oz. Shortening
8 oz. Sugar (sucrose or dextrose)
1½ oz. Malt

Method: Make a sponge of the potato flour, 8 percent of the wheat flour, the yeast and sufficient water to make a fairly thin batter. Allow this to ferment for 1 to 1½ hours, depending on

the degree of maturity desired in the sponge. At the end of the fermentation period, put the remaining water, the salt, sugar and malt into the mixer, add the sponge, and then stir vigorously to dissolve the added ingredients and break up the sponge. Add the flour and begin mixing. When the dough is partially mixed, add the shortening and mix until smooth. The dough should have a temperature of 78° F. when mixed. Allow this dough to ferment until it is thoroughly matured, then divide and make up in the usual manner. Do not give too much proof in the pan. Bake in a slow oven. Potato bread is usually well floured on top to make it stand out as a specialty loaf.

12½% Potato Flour Crackers

87½ lbs. Wheat flour
12½ lbs. Potato flour (fine)
6 lbs. Granulated sugar
3 lbs. Baking ammonia
3 lbs. Milk powder
40 lbs. Water (approximately)
3 lbs. Salt
12½ lbs. Shortening

Method: Cream sugar, shortening, potato flour, salt and milk powder for 5 minutes. Dissolve baking ammonia in the water and add to the creamed ingredients; finally add flour.

Mix the dough for 5 minutes, or until smooth dough is obtained. Run it through the dough brake the desired number of times.

Run on cracker machine or panning machine, according to shape of cracker desired. Potato crackers should be cut thin as they puff in the oven. The best baking temperature seems to be 450° F. Other baking temperatures work satisfactorily, if the necessary changes are made in the formula. Potato crackers are usually sprayed with oil or shortening directly after coming from the oven.

This formula for potato crackers will serve as a general guide in producing a fine potato cracker containing potato flour. Adjustments in the formula can be made to produce crackers suitable to the locality and class of trade.

More Potato Bread as a Possible Means of Increasing Bread Consumption

Per capita bread consumption is reported to have decreased during recent years. This has caused concern among wheat flour millers and bakers alike. An extensive advertising campaign has been instituted to point out to the public the economy, nutritional value, and wholesomeness of bread, rolls,

cakes, and pastries. Everyone recognizes that bread, "the staff of life," is an excellent food and is obtainable at a reasonable price relative to other foodstuffs. Then why is the per capita consumption of bread falling? The question is difficult to answer, but several contributing factors are apparent.

Dieting to control weight is one factor in the declining bread consumption, although many who eat little or no bread consume generous amounts of other foods that are as fattening, or perhaps more so. Some critics of present-day bread say that it has far less taste than bread did years ago. Highly refined, bleached flour certainly has lost some of the flavorful constituents. Some people who object to this buy rye, whole wheat, or other specialty breads made from whole grain flours. Perhaps in developing rapid, streamlined methods of production and in scaling to the minimum the amounts of the more expensive ingredients such as shortening and milk to reduce the price for a competitive market, something has been done to impair the flavor of bread.

The baking industry deserves much credit for its advances during the past 25 to 30 years. Great strides have been made in plant sanitation. Wrapping and preslicing of bread have been universally adopted. Enrichment of bread with vitamins and minerals has been an important contribution to nutrition. Because of the adoption of streamlined production methods, bakers were able to pass on these developments with little or no increase in cost to the consumer until inflation pushed the general price index upward. Although the "old-fashioned" type of bread has become a rather good seller recently at a premium price, ordinary white bread, the bakers' largest item, cannot be made by old-fashioned methods and sold at a profit under our present economy.

People like variety in breads as in other foods. A person will tire of the finest bread if he does not change occasionally to another kind, say from white to whole wheat or rye bread. Certain bakers have made an outstanding success featuring potato bread, but in many sections of the country potato bread is virtually unknown and unavailable. Bread containing about 6 percent potato flour should be more widely tried as a specialty bread to help relieve the monotony of eating common, ordinary breads every day.

Specialty breads fit into the operations of the small retail bakery better than into those of large wholesale bakeries. Wholesale bakers justifiably object to making any more varieties of bread than are required by the

trade. Changeovers in mixing and makeup machinery cause loss in production efficiency, with resultant higher production costs. Selling costs also rise as the number of varieties increases. However, regular white bread containing 2 to 4 percent potato flour should be given a thorough trial by the larger baking companies in the attempt to improve flavor and other aspects of appeal without sacrificing mass production efficiency.

Potato flour is not to be considered as a competitor of wheat flour. They are entirely different in their properties. Potato flour is not a replacement for a given quantity of wheat flour but is instead a conditioner or modifier for bread.

If consumption of bread could be substantially increased by regular use of potato flour, agriculture and industry alike would benefit. Farmers would profit by an expanded outlet for cull and surplus potatoes. The potato flour manufacturer would have a greater market for his product. The wheat miller would experience a greater demand for flour. Lastly, the baker would benefit by the augmented consumption of a basic foodstuff that is of such prime importance in good nutrition.

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